IBM Global Business Services

Introduction to TRIZ

- Theory of Inventive Problem Solving

Теория Решения Изобретателъских Задач

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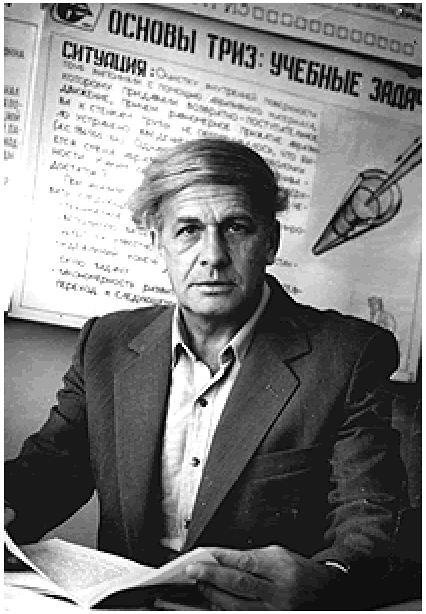
TRIZ - Introduction

- TRIZ is Russian acronym for the Theory of Inventive Problem Solving.
- TRIZ provides a structured way of doing innovations and changes the way a engineer would approach a problem
- TRIZ is developed by analyzing patents thus, when TRIZ is applied to solve a problem it brings the vast knowledge available in patents database
- TRIZ is developed by Russian Scientist Genrich Altshuller in 1940's, the basic form of TRIZ and it's 40 operators are available in public Domain free of cost. However subsequent advancements to Triz are commercialised.
- This presentation explains some of the basics of TRIZ.



What is TRIZ?

TRIZ is a set of systematic thinking tools that can help to improve ‘systems’ in innovative ways.

TRIZ uses a distillation of all recorded solutions in 4 simple lists:

- 40 inventive principles
- 8 trends of technical evolution
- 76 standard solutions
- 2500+ engineering & scientific concepts arranged as questions and answers

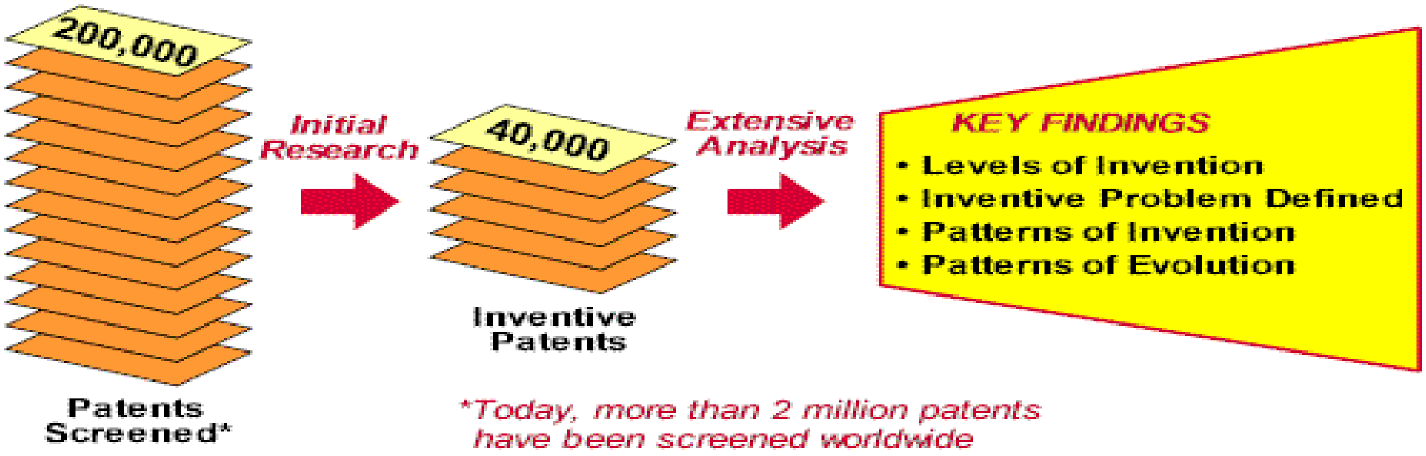
TRIZ is an alternative to either:

- jumping to solutions, or
- starting from scratch

The Origins of TRIZ

Altshuller analyzed the patent fund, screening over 200,000 patents from all over the world as he believed that Innovation represents a fundamental change to a technological system – and is therefore subject to analysis.

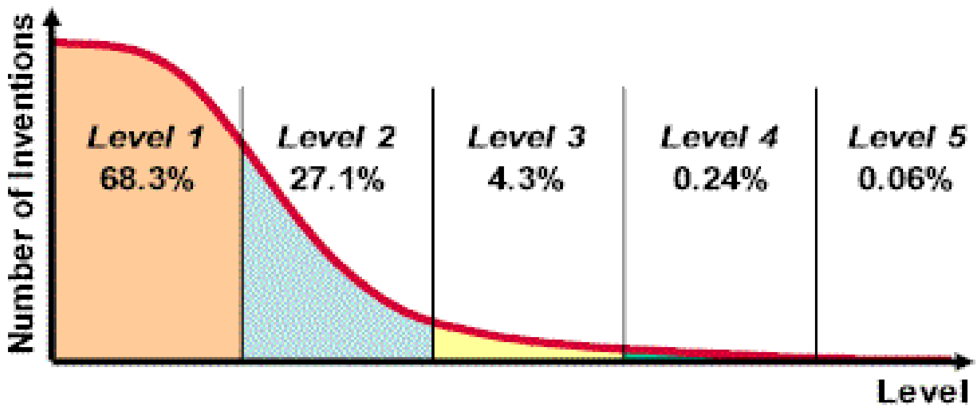
He identified **40,000** patents that constituted "inventive" achievements, and began a **rigorous analysis** of these. The results of his efforts formed the theoretical basis of TRIZ and laid the groundwork for the problem-solving tools that would later be developed.



by 1990 over 2 million patents had been investigated.

Result #1 - Levels of invention

- **Level 1 -** Routine design problems solved by methods well known within the specialty. Usually no invention needed.
- **Level 2 -** Minor improvements to an existing system using methods known within the industry.
- **Level 3 -** Fundamental improvement to an existing system using methods known outside the industry.
- **Level 4 -** A new generation of a system that entails a new principle for performing the system's primary functions. Solutions are found more often in science than technology.
- **Level 5 -** A rare scientific discovery or pioneering invention of an essentially a new system.



Result # 2 – Inventive Problem Solving

- An inventive problem usually has one or more of:
  - no known solution
  - **psychological inertia** (human belief that solution is not achievable)
  - **contradictions**. (A contradiction is a situation where an attempt to improve one feature of the system leads to the degradation of another feature.)

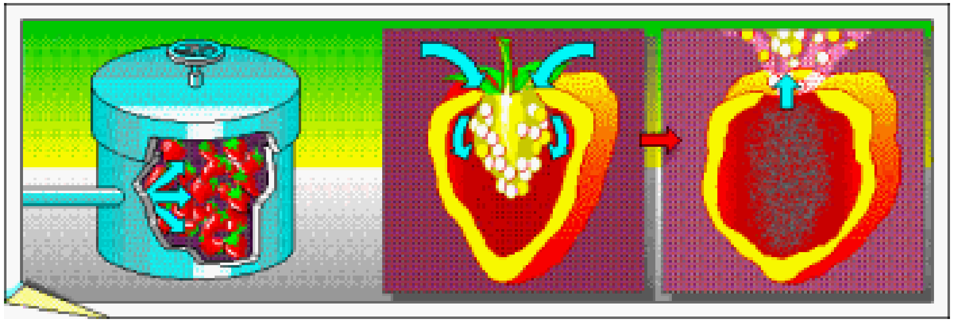
New Knowledge	New knowledge applied to known problems. Example: New plastics provide strong, lightweight products.	New knowledge applied to new problems. Example: Various uses for lasers (surgery, etc).
Existing Knowledge	Existing knowledge applied to known problems. Example: All tasks with generally known solutions.	Existing knowledge does not provide satisfactory solution. We are dealing with an **inventive problem**
	Known Problem	**New Problem**

Result # 3 - Patterns of Invention

- Same fundamental problem (contradiction) had been addressed by multiple inventions throughout different areas of technology. Moreover, the same **fundamental solutions** had been used over and over again, often separated by many years. Altshuller identified **40 principles** embodied in these solutions. Today, the screening of more than **two million patents** has yielded **440 principles** in I-Triz.

- Example of an operator: **Concentrate and release energy**.

  To split apart a product containing pores or cracks: Place the product in a hermetic chamber. Slowly increase the pressure inside the chamber, then reduce it abruptly. The drop in pressure creates a momentary pressure difference inside and outside the product, which causes it to "explode."



Other operators – Segmentation, inversion, Periodic action, etc

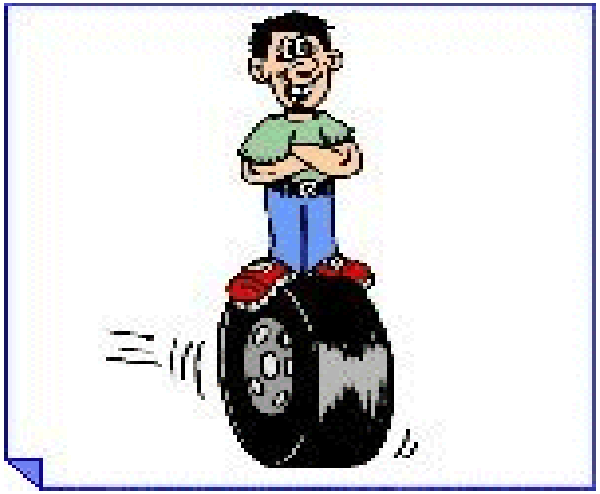
Note – I Triz is the commercial version of Triz developed by Ideation Inc

Result # 4 - Patterns of Evolution

Patterns of Evolution – study of patents has revealed that there is a common statistically proven threads between evolving systems, which can be used to predict future of a system.

One of the Pattern in evolution is “Technological systems tend to evolve in the direction of increasing ideality “

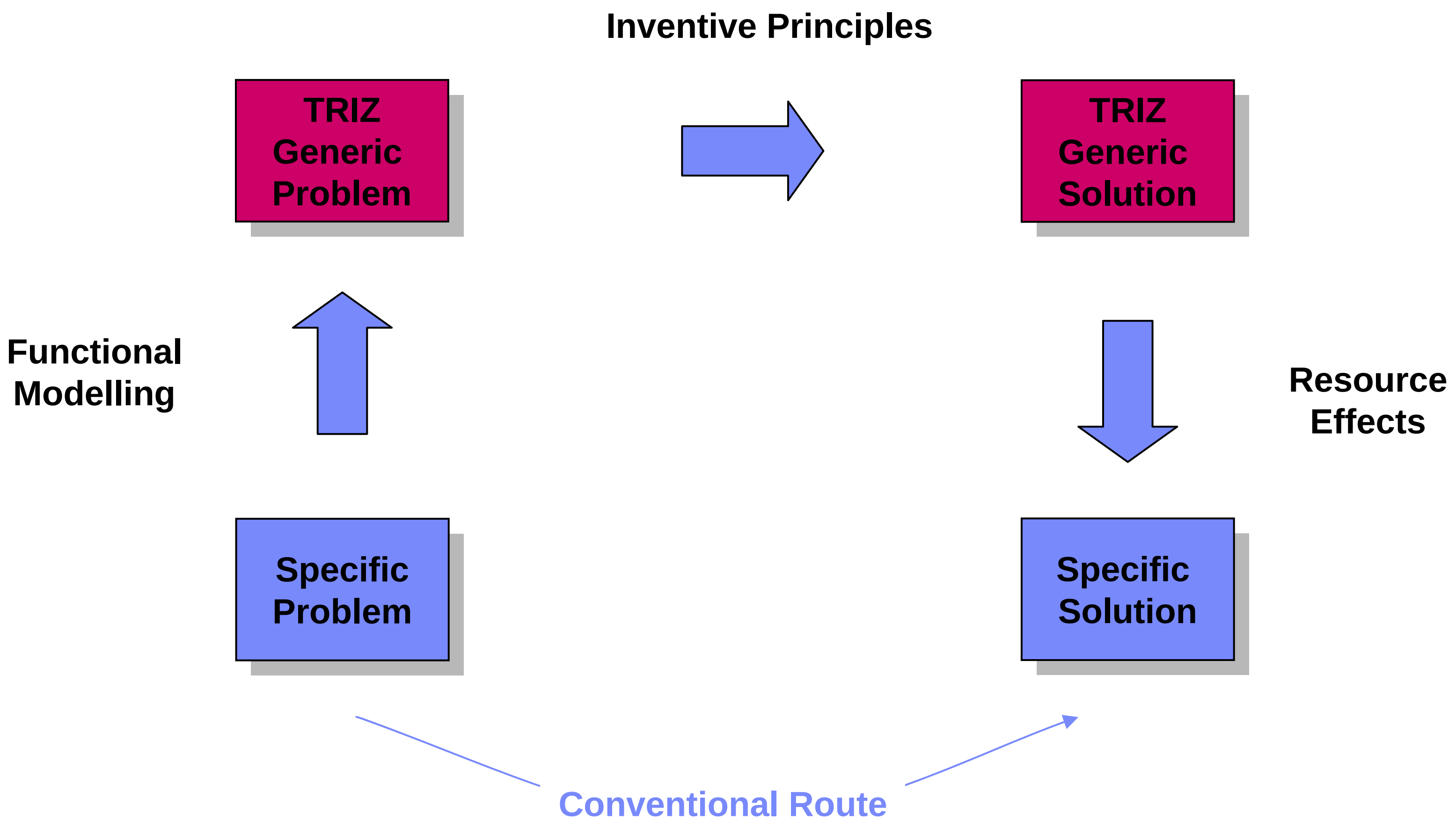
“An ideal system is one whose functions are performed without the system existing.”



Achieving Transportation without a vehicle is **ideality** for a transportation system.

While a vehicle running without fuel is **local ideality**, for a **subsystem** vehicle.

Problem solving: The General TRIZ Process

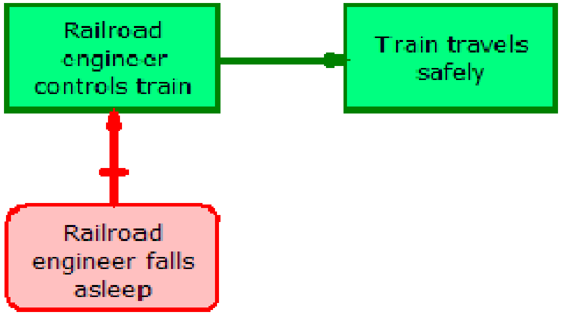


Steps in Problem solving using TRIZ

- Step 1 – Define objective and situation
  - What problem should be solved
  - system , its super & sub systems
  - Resources, constraints limitations
  - Other systems where similar problem is solved
- Step 2 – Problem Formulation and brain storming
  - Modeling - detailed visual description of the system with useful, harmful functions and contradictions.
  - Formulate exhaustive set of directions and specific tasks
- Step 3 – Prioritize directions for Innovation
  - Brainstorm to generate ideas on prioritized directions
  - Identify the functions performed by ideas
- Step 4 – Develop concepts
  - Combining ideas into concepts through the utilization of resources.
- Step 5 – Create a plan to implement concepts
- Step 6 – Evaluate results

Problem Formulation

Problem Formulation – A logical diagram of the problem describing the harmful and useful functions of system and it's subsystem (similar to cause effect)



Convert the cause effect diagram into specific tasks required to solve the problem.

→ Find a way to eliminate, reduce, or prevent, "railroad engineer falls asleep" and provide "railroad engineer controls train" then think how to provide "Train Travels Safely" .

Contradictions

Technical contradictions are the classical engineering "trade-offs." The desired state can't be reached because something else in the system is compromised or prevents it. In other words, when something gets better, something else gets worse. For example:

∗ The product gets stronger (good) but the weight increases (bad)

∗ The bandwidth increases (good) but requires more power (bad)

∗ Service is customized to each customer (good) but the service delivery system gets complicated (bad.)

∗ The automobile airbag should deploy very fast, to protect the occupant (good) but the faster it deploys, the more likely it is to injure or kill small people or out of position people (bad)

Physical contradiction are situations where one object has conflicting features/benefits. Everyday examples abound:

∗ Surveillance aircraft should fly fast (to get to the destination) but should fly slowly to collect data directly over the target for long time periods.

∗ Software should be easy to use, but should have many complex features and options.

∗ Coffee should be hot, for enjoyable drinking, but cold, to prevent burning the customer

∗ Training should be thorough and not take any time

Technical Contradictions

Attempt to improve one feature of a system causes another feature to degrade is called a **contradiction**.

Examples:

- Increased acceleration in an automobile also increases fuel consumption.
- A pen tip should be sharp to draw legible lines, but blunt to avoid tearing the paper.
- Aircraft landing gear is necessary for takeoff and landing, but is undesirable during flight.
- I like to get paid, but I don't like to work!

The Contradiction Matrix directs us to Inventive Principles for solution.

- Contradictions are classified in 39 Technical Parameters
  - Vertical Axis = gets better
  - Horizontal Axis = gets worse

Contradiction Matrix

	Worsening Feature → / Improving Feature ↓	Volume of moving object	Speed	Force (Intensity)	Stress or pressure	Shape	Reliability	Object-generated harmful factors	Ease of operation	Ease of repair	Device complexity	Difficulty of detecting and measuring
		7	9	10	11	12	27	31	33	34	36	37
9	Speed	7, 29, 34	+	13, 28, 15, 19	6, 18, 38, 40	35, 15, 18, 34	11, 35, 27, 28	2, 24, 35, 21	32, 28, 13, 12	34, 2, 28, 27	10, 28, 4, 34	3, 34, 27, 16
10	Force (Intensity)	15, 9, 12, 37	13, 28, 15, 12	+	18, 21, 11	10, 35, 40, 34	3, 35, 13, 21	13, 3, 36, 24	1, 28, 3, 25	15, 1, 11	26, 35, 10, 18	36, 37, 10, 19
11	Stress or pressure	6, 35, 10	6, 35, 36	36, 35, 21	+	35, 4, 15, 10	10, 13, 19, 35	2, 33, 27, 18	11	2	19, 1, 35	2, 36, 37
12	Shape	14, 4, 15, 22	35, 15, 34, 18	35, 10, 37, 40	34, 15, 10, 14	+	10, 40, 16	35, 1	32, 15, 26	2, 13, 1	16, 29, 1, 28	15, 13, 39
15	Duration of action of moving object	10, 2, 19, 30	3, 35, 5	19, 2, 16	19, 3, 27	14, 26, 28, 25	11, 2, 13	21, 39, 16, 22	12, 27	29, 10, 27	10, 4, 29, 15	19, 29, 39, 35
33	Ease of operation	1, 16, 35, 15	18, 13, 34	28, 13 35	2, 32, 12	15, 34, 29, 28	17, 27, 8, 40		+	12, 26, 1, 32	32, 26, 12, 17	

Physical Contradiction

TRIZ offers 4 ways to resolve physical contradictions by separating contradictory requirement

1. **Time** (Try to schedule the process so that conflicting requirements, functions, or operations take effect at different times.)

   ex . Reviews in a team can be conducted at a separate fixed time

2. **Space** (Separate contradictory requirements, functions or conditions by assigning each one to a different location.)

   ex . There can be a separate space to perform a specialized functions

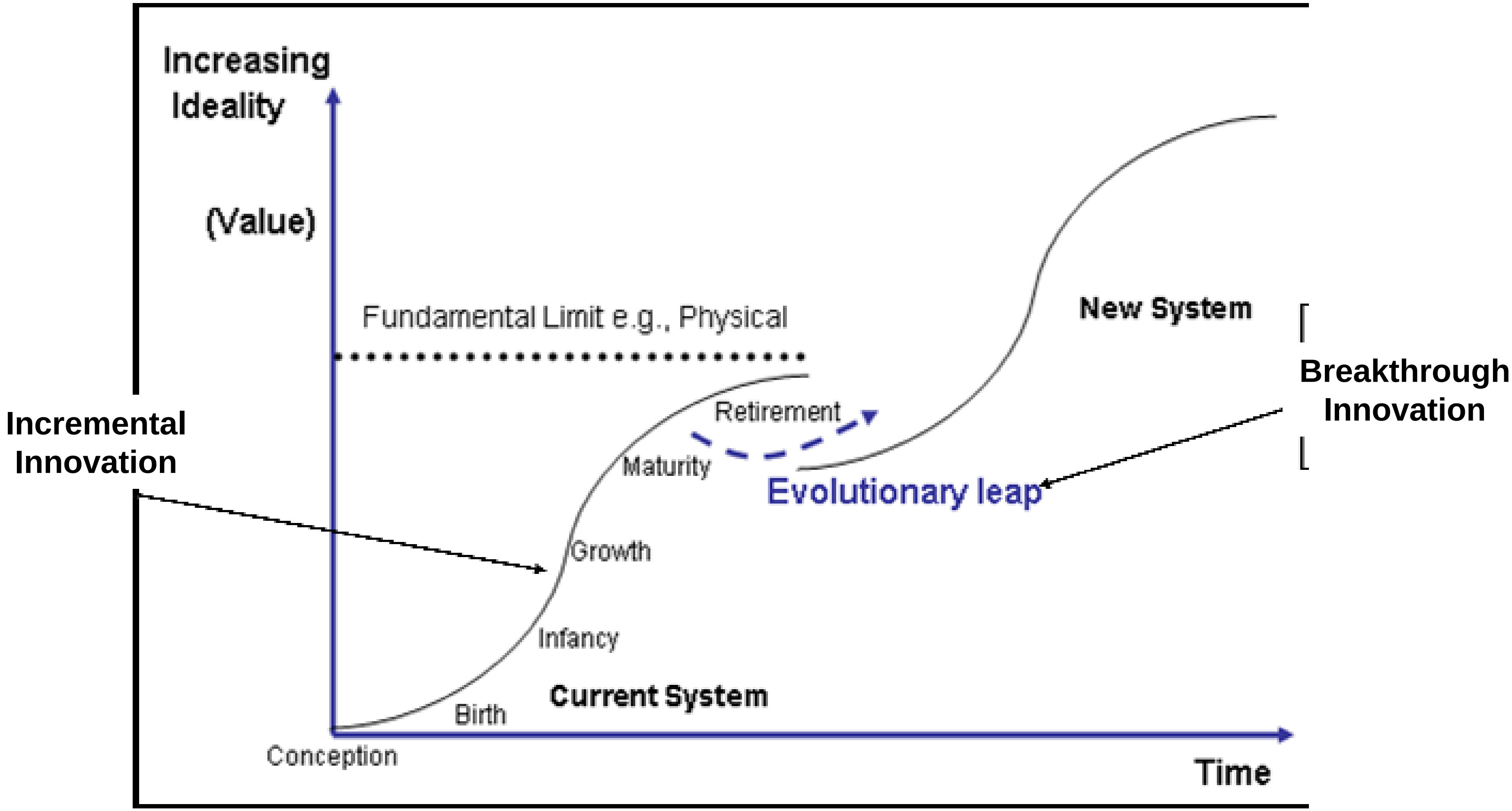
3. **Condition** (Look for a parameter or condition that can change so the system can meet one requirement under one condition and the opposite requirement under another condition.)

4. **Alternative Ways/Structure** (Try to separate contradictory requirements, functions or conditions between different structural elements of the system.)

Trends of Evolution

- Increasing Ideality
- Evolution in stages (S-Curves)
- Reducing human involvement
- Non-uniform evolution of parts
- Simplicity > Increased Complexity > Super Simplicity
- Increasing segmentation
- Increasing dynamism and control
- Mismatching& Matching

The ‘S’ Curve


Increasing
Ideality
(Value)
Fundamental Limit e.g., Physical
New System
Breakthrough
Innovation
Retirement
Maturity
Evolutionary leap
Incremental
Innovation
Growth
Infancy
Current System
Birth
Conception
Time

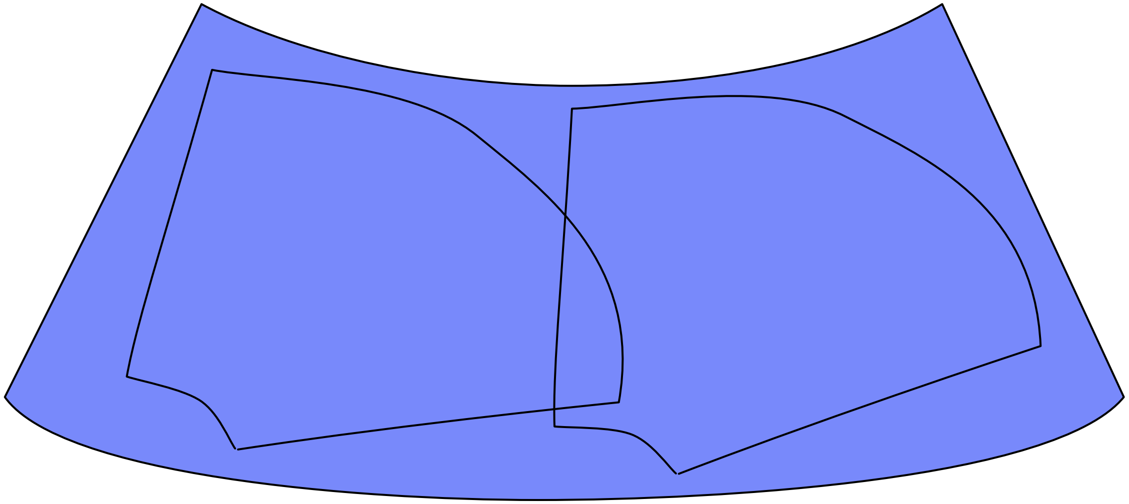
Exercise: ‘S’ Curves

Where are these on the ‘S’ Curve?

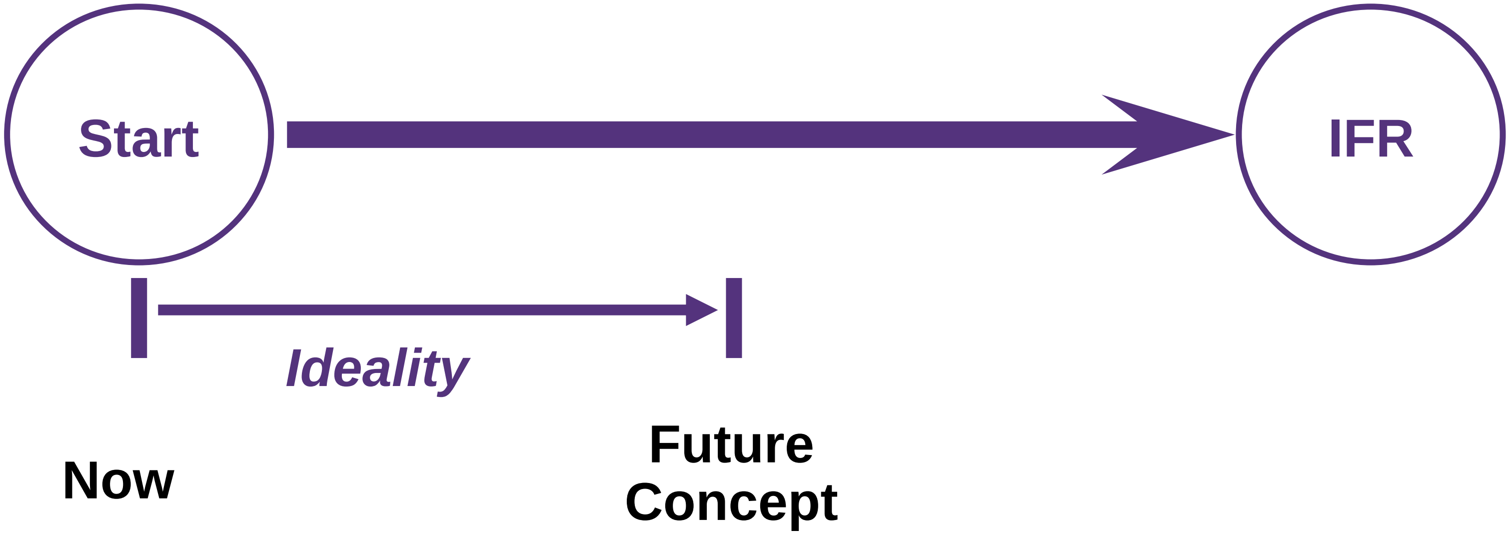
- Gas Turbine
- Fuel Cell
- Teabag
- Memory Stick
- Medical X ray
- Magnetic Resonance Imaging
- Bicycle
- Internal Combustion Engine
- LCD Projector
- Flat Screen TV
- Piano
- GPS
- Computer
- Printing Press
- Mobile Phone
- Light Bulb
- Fountain Pen

Exercise: Trends

What is the evolutionary path for windscreen wipers?



"Ideality" Measures Progress Toward The IFR (Ideal Final Result)



Innovative breakthroughs always increase the "IDEALITY" of the system.

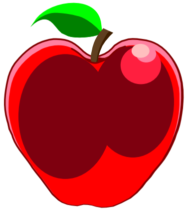
What Is Ideal Final Result?

- Ideal Final Result (IFR) describes solution to a problem, independent of:
  - Mechanism of the original problem
  - Constraints of the original problem
- The IFR describes (defines) an ideal system which delivers benefit without harm:
  - Occupies no space
  - Has no weight
  - Requires no labor
  - Takes no time
  - Requires no maintenance, etc.

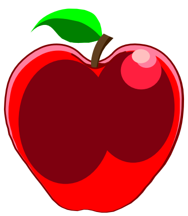
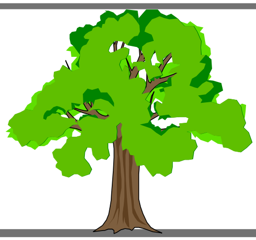
Why Create The IFR?

- Technology Forecasting:
  - To establish the direction of the project
- Problem Solving:
  - Temporarily gets people to think **“out of the box”**
  - Removes perceived or real barriers by offering alternative solution concepts
  - Starts with “perfection” – Not limitations
    - Encourages **Breakthrough Design**
    - Inhibits moves to less ideal solutions
    - Leads to the discussions that will clearly establish boundaries of the project

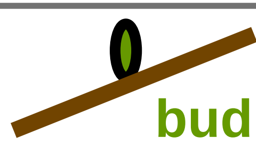
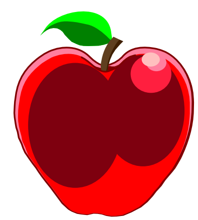
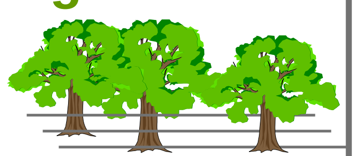
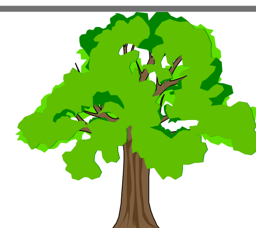
9 Ways To Think About The Problem

	Past (preventive)	Present	Future (corrective)
Sub-System			
System			
Super-System			

9 Ways To Think About The Problem (Present)

	Past (preventive)	Present	Future (corrective)
Sub-System		**peel, stem, flesh, seed**	
System			
Super-System			

9 Ways To Think About The Problem (Past And Future)

	Past (preventive)	Present	Future (corrective)
Sub-System		**peel, stem, flesh, seed**	**soak slices in liquid**
System	 **bud, coating**		**store in high humidity**
Super-System	**irrigate** 		

Close

- This is just a brief taster!
- Sources:
  - Oxford Creativity (www.triz.com)
  - Systematic Innovation by Darrell Mann
  - And Suddenly the Inventor Appeared